The Use of Colour and Aesthetics in Data Visualizations

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PSYC 6135
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Agenda

- Colour and Aesthetics Processing
- Colour Psychology
- Colour & Memory Retention
- Colour Selection
- Other Aesthetic Principles to Consider
- Summary of Aesthetic Considerations for Creating Data Visualizations
- Comments/Questions

How do you currently consider aesthetic principles when making your own data visualizations?

Leveraging Aesthetics in Data Visualization

– – –

- While we want our visualizations to be aesthetically pleasing to our audience, the main goal is not for a visualization to look ‘good’ or ‘pretty’
- Colour theory and aesthetic principles can be used to assist you in disseminating your results effectively and to assist your audience in clearly identifying your key findings
- An excellent tool to have at the ready…

How We Process Visual Information

A jump back into Sensation & Perception I…

- Visual stimuli is received by the retina, then transmitted to the brain for processing
- Processing aesthetic information (i.e. colour, shape, size, position) occurs in ~13 milliseconds (Potter et al., 2014)
- Carefully selecting colour and other aesthetics in your data visualizations capitalizes on this process
    - Making your standout findings easier to process for your audience

What Makes Up A Colour?

Psychological Impact of Colour

- Colour psychology has well established that colour affects human behaviours, physiological response, and cognition
- Colour can evoke emotional responses, as well as influence mood

Colour and Emotion

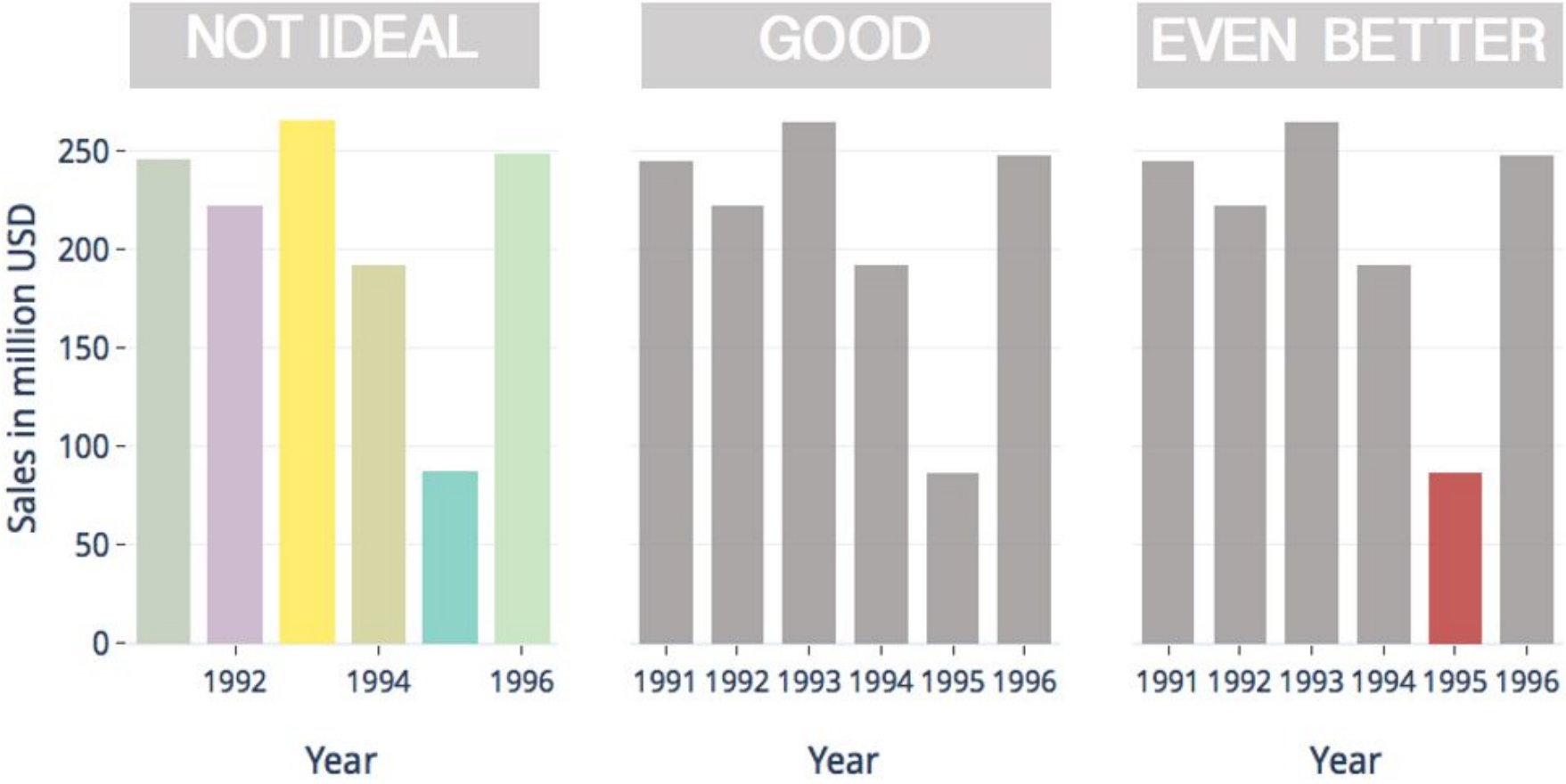
- There are universal patterns in relating colour to feeling (Jonauskaite et al., 2020)
  - Black (51%) = Sadness
  - White (43%) and Blue (35%) = Relief
  - Red (68%) and Pink (50%) = Love
  - Green (39%) = Contentment
  - Yellow (52%) and Orange (44%) = Joy
  - Purple (25%) = Pleasure
  - Brown (36%) = Disgust

Other Colour Association Findings

- White-coloured pills are associated with greater pain relief (Amawi & Murdoch, 2022)
    - Red-coloured pills are associated with greater stimulant properties
- Red causes people to react with greater speed and force (Elliot & Aarts, 2011)
    - Red cars are ticketed more often than cars of other colours
- Sports players in black uniforms are more likely to receive penalties than players wearing other colours (Frank & Gilovich, 1988)

Role of Colour in Memory Retention

- Colour tells your audience what they should be paying attention to
  - Colour helps in memorizing information by increasing attention levels
- Increased attention on stimuli improves the transferring of information to memory (Sternberg, 2009)
- Warm colours have a greater effect on attention compared to cool colours (Greene et al., 1983)
- We can identify colour differences much faster than we can shape differences (Pan, 2009)
  - Colours have a better ability to capture attention than other aesthetic changes


NOT IDEAL
GOOD
EVEN BETTER
Sales in million USD
250
200
150
100
50
0
1992
1994
1996
1991 1992 1993 1994 1995 1996
1991 1992 1993 1994 1995 1996
Year
Year
Year

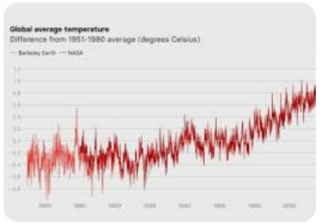
Where do we most often see colour psychology in action?

MARKETING

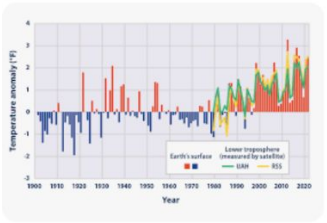
Brands by Color

Red
Excitement
Strength
Love
Energy
Orange
Confidence
Success
Bravery
Sociability
Yellow
Creativity
Happiness
Warmth
Cheer
Green
Nature
Healing
Freshness
Quality
Blue
Trust
Peace
Loyalty
Competence
Pink
Compassion
Sincerity
Sophstication
Sweet
Purple
Royalty
Luxury
Spirituality
Ambition
Brown
Dependable
Rugged
Trustworthy
Simple
Black
Formality
Dramatic
Sophistication
Security
White
Clean
Simplicity
Innocence
Honest

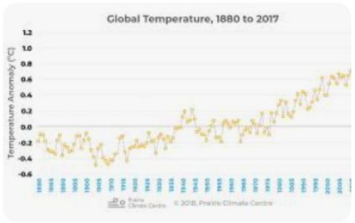
Example: Climate Change



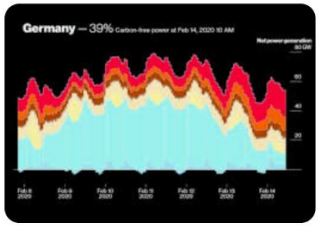
BuzzFeed News
Climate Change Data And Charts: G…



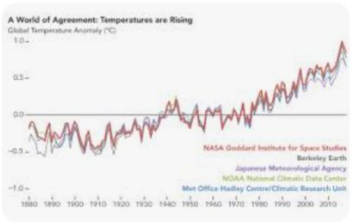
Environmental Protection Agency
Climate Change Indicators: U.S. and ...



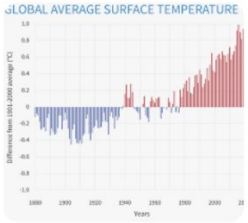
Climate Atlas of Canada
Climate Atlas of Canada



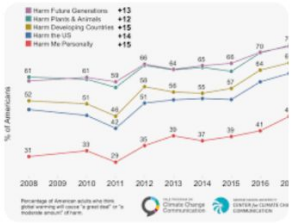
Center for Data Innovation
Visualizing Climate Change Data in …



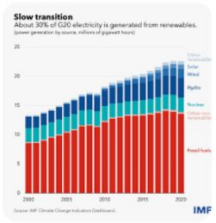
Mind the Graph
Demystifying climate change through ...



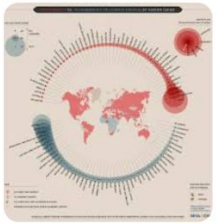
Climate.gov
Climate Change: Global Te…



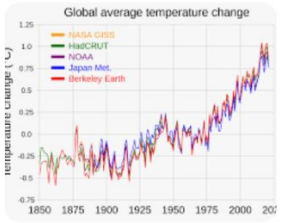
Yale Program on Climate Change C…
Climate Change in the American …



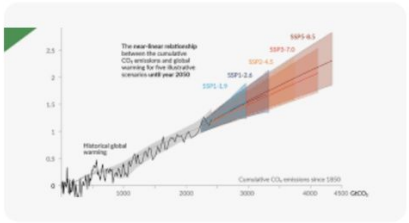
IMF International Monetary F…
Bridging Data Gaps Ca…



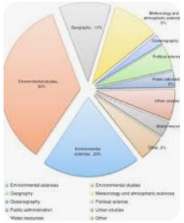
Public Health Degrees - …
Graphic] CO2 Emissio…



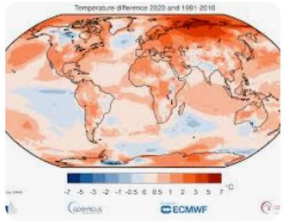
Solutions to Climate Change
Climate Change data analysis |…



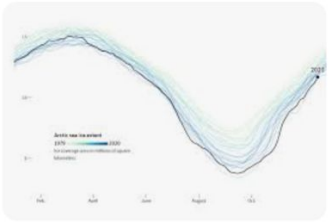
IPI Global Observatory
New Climate Data Visualizations, 2021 ...



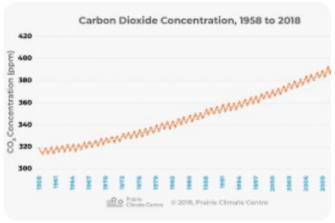
Wiley Interdisciplin…
n comparative clim…



Copernicus Climate Change Service
Copernicus: 2020 warmest year…



AnyChart
Data Visualizations on Climate Chang…



Climate Atlas of Canada
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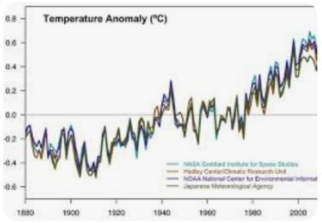
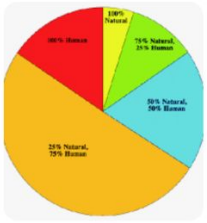
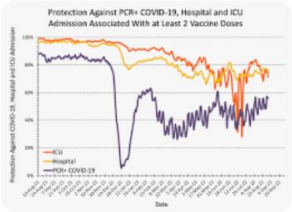


ACAP Saint John
Climate Change Globally — ACAP S…

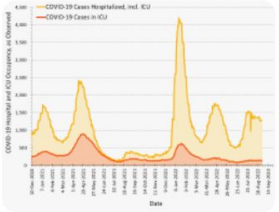


ResearchGate
Belief in the causes of…

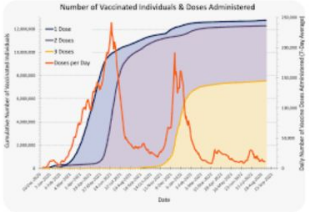
Example: COVID-19



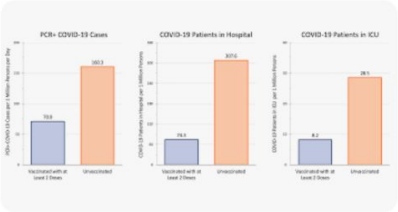
Ontario COVID-19 Science Advisory T…
Ontario Dashboard - Ontario COVI…



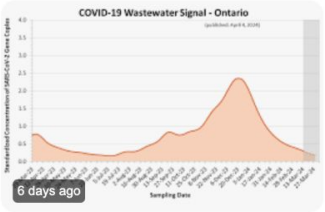
Ontario COVID-19 Science Advisor…
Ontario Dashboard - Ontario CO…



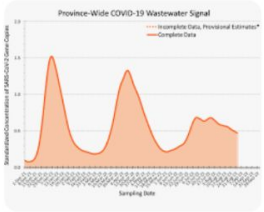
Ontario COVID-19 Science Advisory Table
Ontario Dashboard - Ontario COVID…



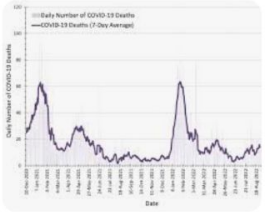
Ontario COVID-19 Science Advisory Table
Ontario Dashboard - Ontario COVID-19 ...



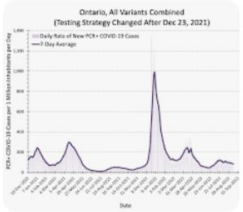
Public Health Ontario
COVID-19 Wastewater Surveillance in ...



Ontario COVID-19 Science Advis…
Ontario Dashboard - Ontario C…

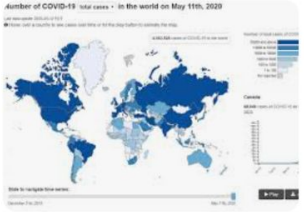


Ontario COVID-19 Science Advis…
Ontario Dashboard - Ontario C…



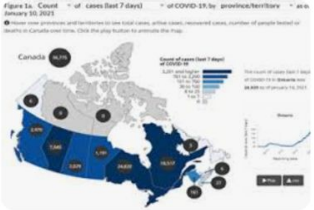
Ontario COVID-19 Science A…
Ontario Dashboard - Ontari…

Tableau
COVID-19 (Coronavirus) Data Hub | Ta…

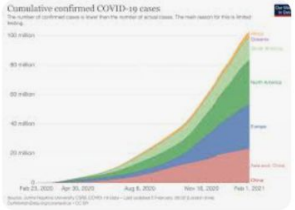


Health Infobase - Canada.ca
COVID-19 visual data gallery - Publ…

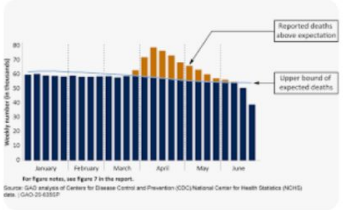
CBC
Ontario needs to be …



Health Infobase - Canada.ca
COVID-19 visual data gallery - Public ...



Our World in Data
Canada: Coronavirus Pandemic C…



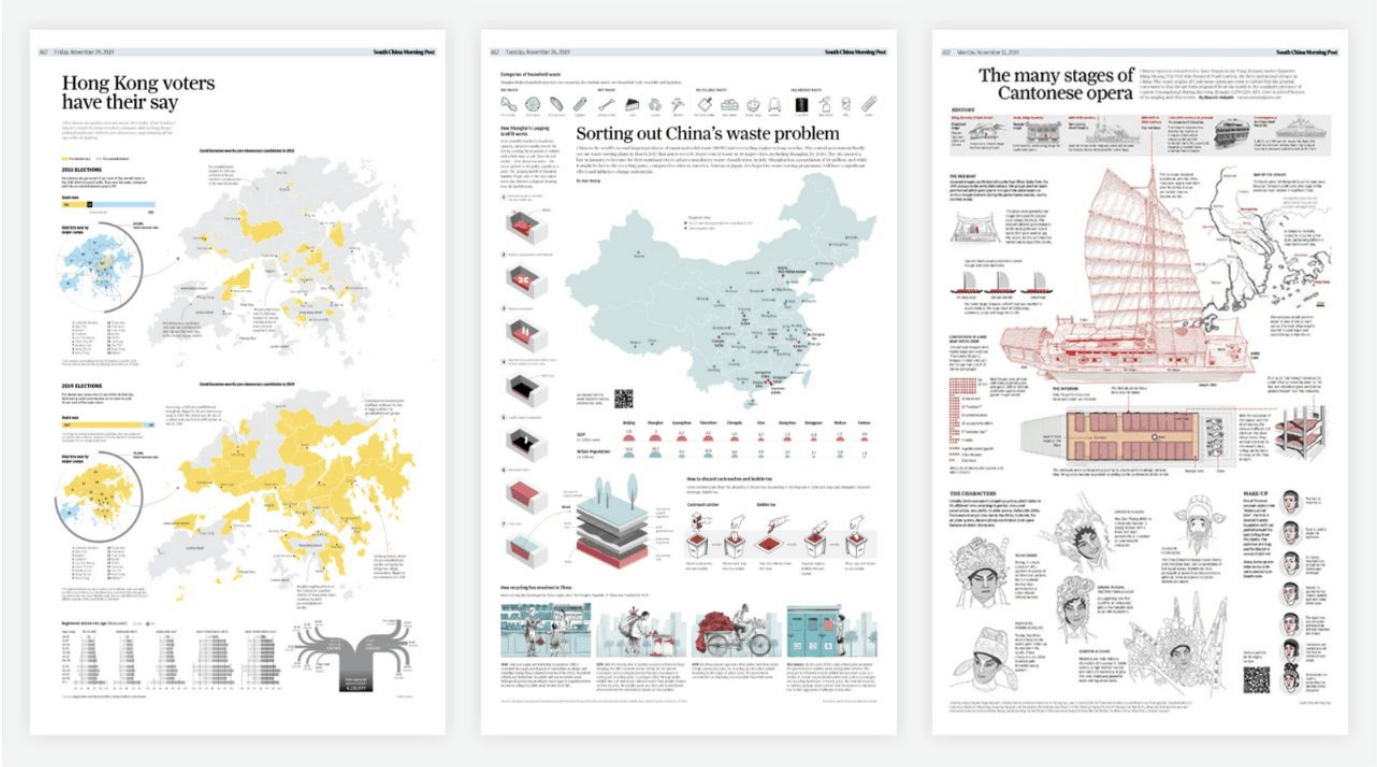
GAO
Covid-19: Data Quality and ...

CIDRAP
COVID-19: Data Visualizations | CIDRAP

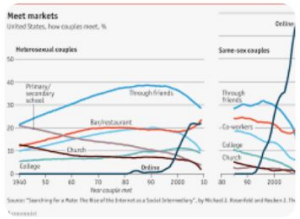
CBC
The flurry of daily pandemic data can ...

Interesting finding: Use of warm colours with blue is very often seen in news sources

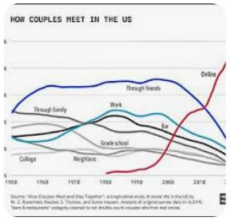
- Differences between warm colours is very easy for the brain to distinguish against a cool colour, such as blue
- Warm colours can grab attention, while blue can provide a sense of trustworthiness and reliability in the source



Example: Dating

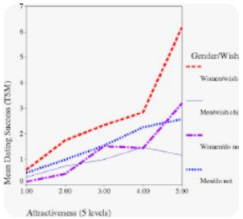


The Economist
The irresistible rise of internet dating

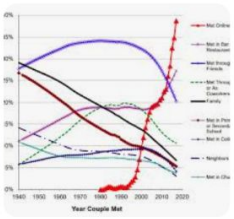


Kevin Drum
How great is online datin…

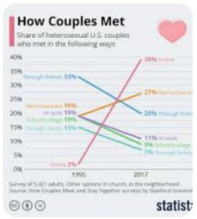
Statista
Chart: Looking For L…



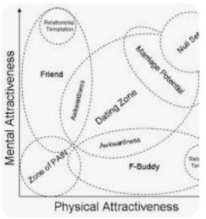
ResearchGate
Graph of Dating Success (…



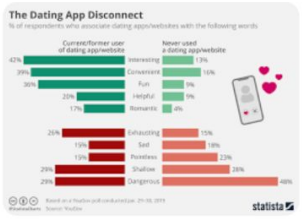
GOAT
This Graph Showing How …



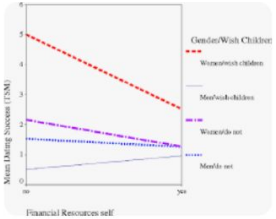
Statista
Chart: How Couples …



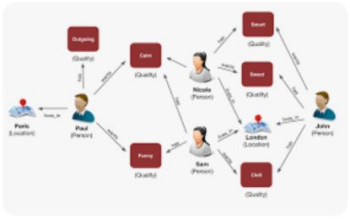
The Adventures of Acc…
The Attractiveness/Rel…



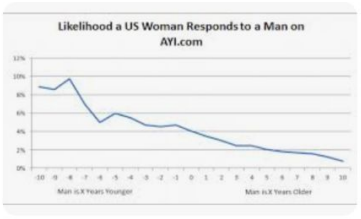
Statista
Chart: The Dating App Disconnect |…



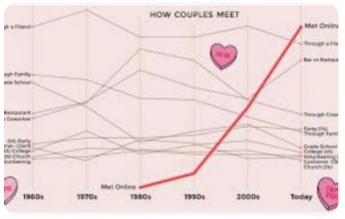
ResearchGate
Graph of Mean Dating Success…



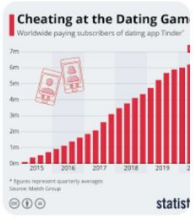
Linkurious
an online dating use case



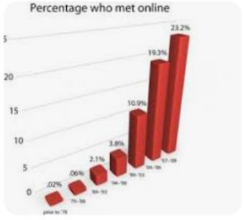
Yahoo Finance
One Chart That Shows How Women Are At…



Visual Capitalist
The Rise of Online Dating, and the …



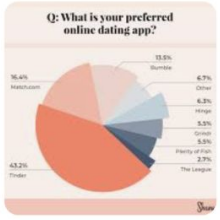
Statista
Chart: Cheating at th…



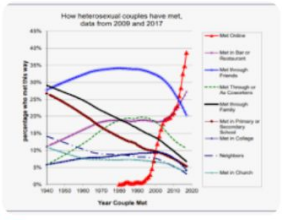
Phys.org
Online dating research sho…

GWI Blog
Online dating market…

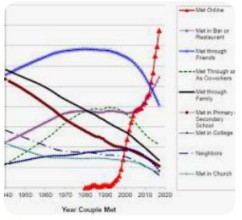
Visual Capitalist
The Rise of Online Datin…



Shane Co.
The Dos and Don'ts of …

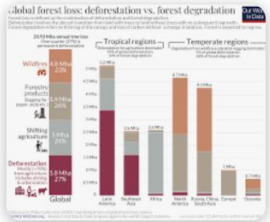


Marginal REVOLUTION
Pretty stunning data on dating …



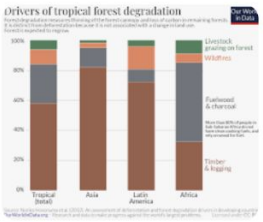
Steve Stewart-Williams
Graph of the Day: How Co…

Example: Deforestation



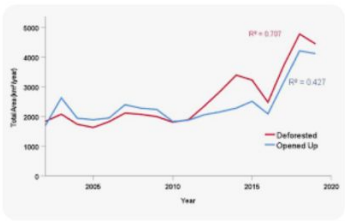
Our World in Data

Deforestation and Forest Loss…



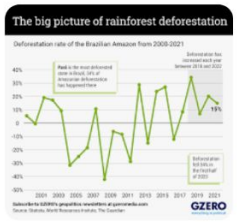
Our World in Data

Deforestation and Forest Los…



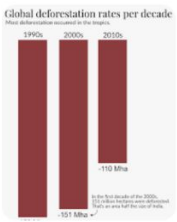
ResearchGate

Line graph showing the deforestation ...



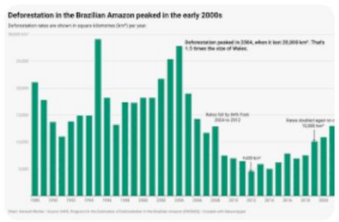
GZERO Media

big picture of rainforest de…



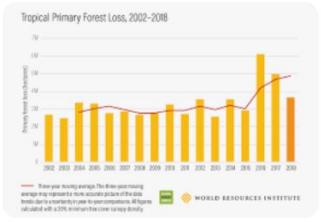
Our World in Data

Deforestation and …



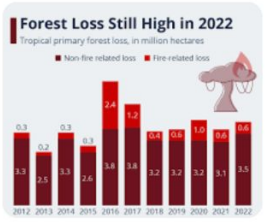
Sustainability by numbers

Is deforestation in the Amazon falling ...



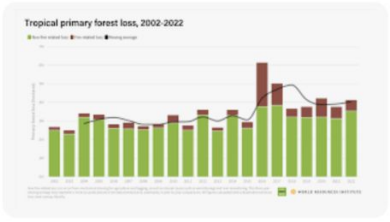
The World Economic Forum

These charts show just how much for…



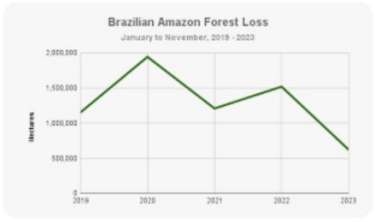
Statista

Chart: Forest Loss Still High i…



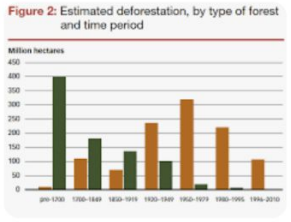
Earth.Org

Stunning Deforestation Facts



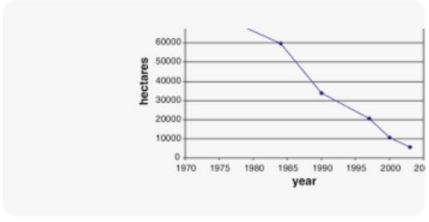
MAAP

MAAP #201: Amazon Deforestation ...



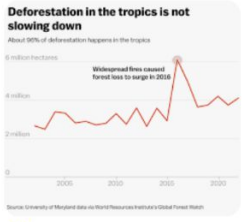
Nature pictures

Deforestation Estimates



ResearchGate

Graph of deforestation area between ...

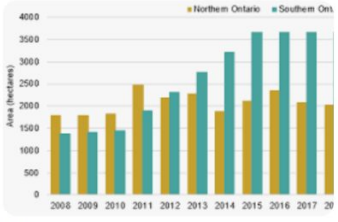


Vox

Tropical rainforests are still ...

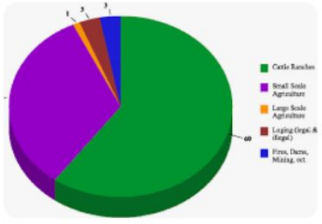
Visual Capitalist

Forests Since the Ice-Age



State of Ontario's Biodiversity

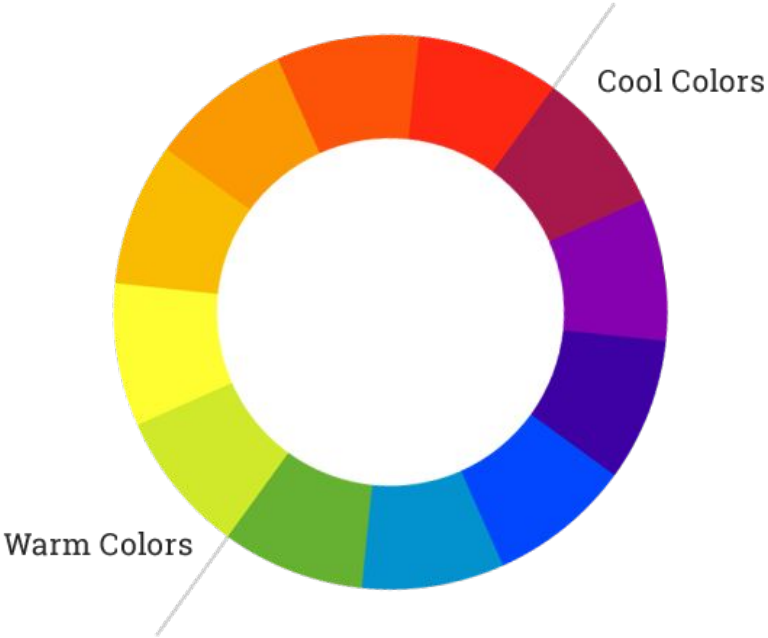
Afforestation and Deforestation ...

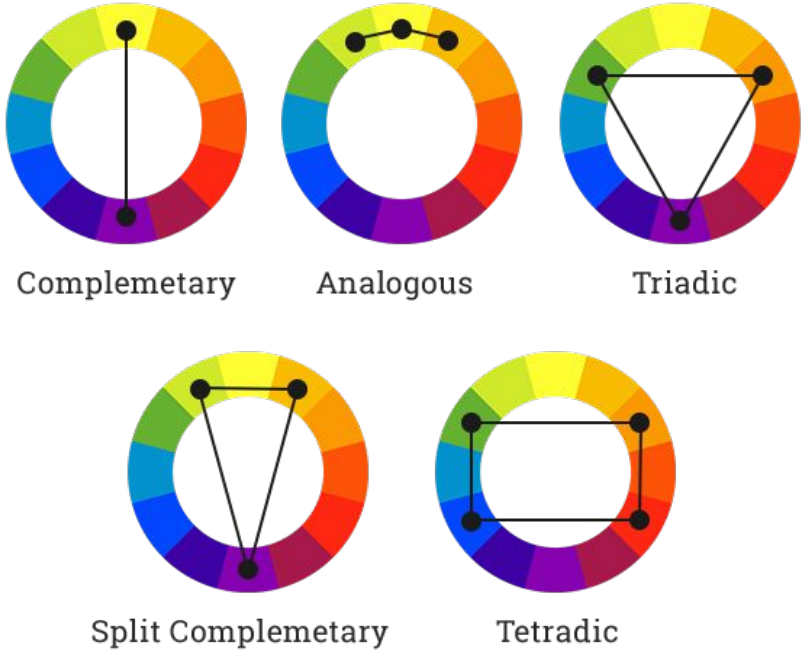


deforestation - Weebly

Graphs and Visual Aids - DEFOREST…

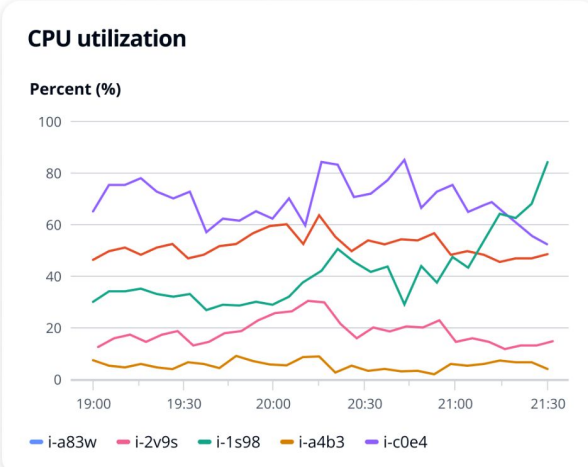
Using Colour Theory for Colour Selection

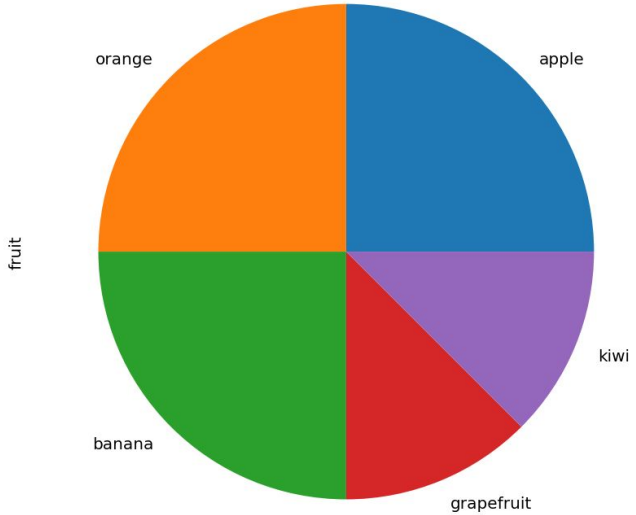




How to Choose the Ideal Colours for Your Visualizations

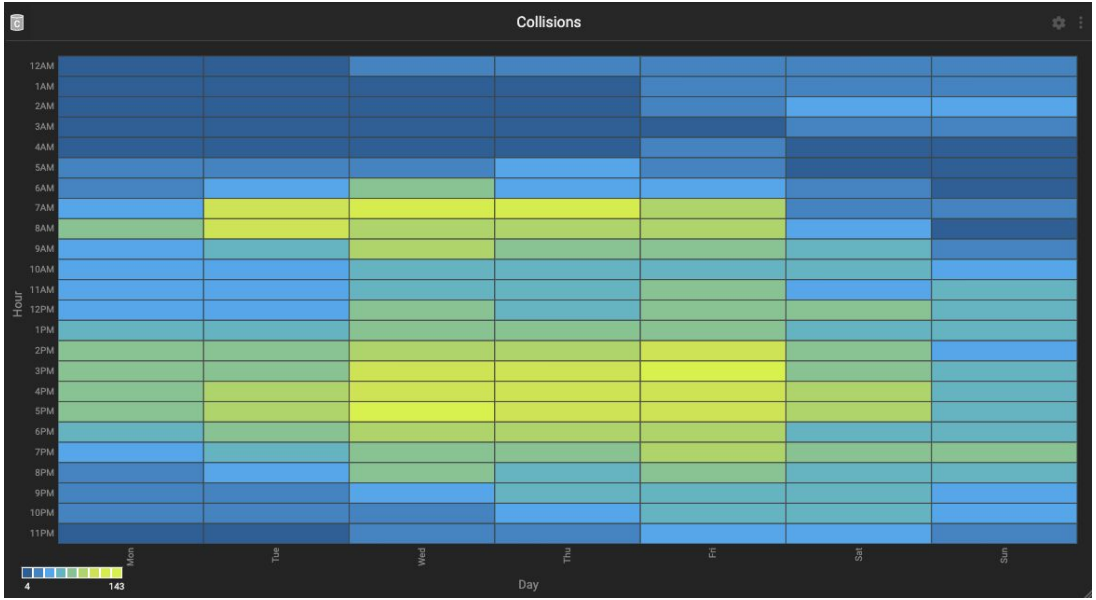
- Categorical (Qualitative) palette — each colour is distinct
  - Ideal for categorical data





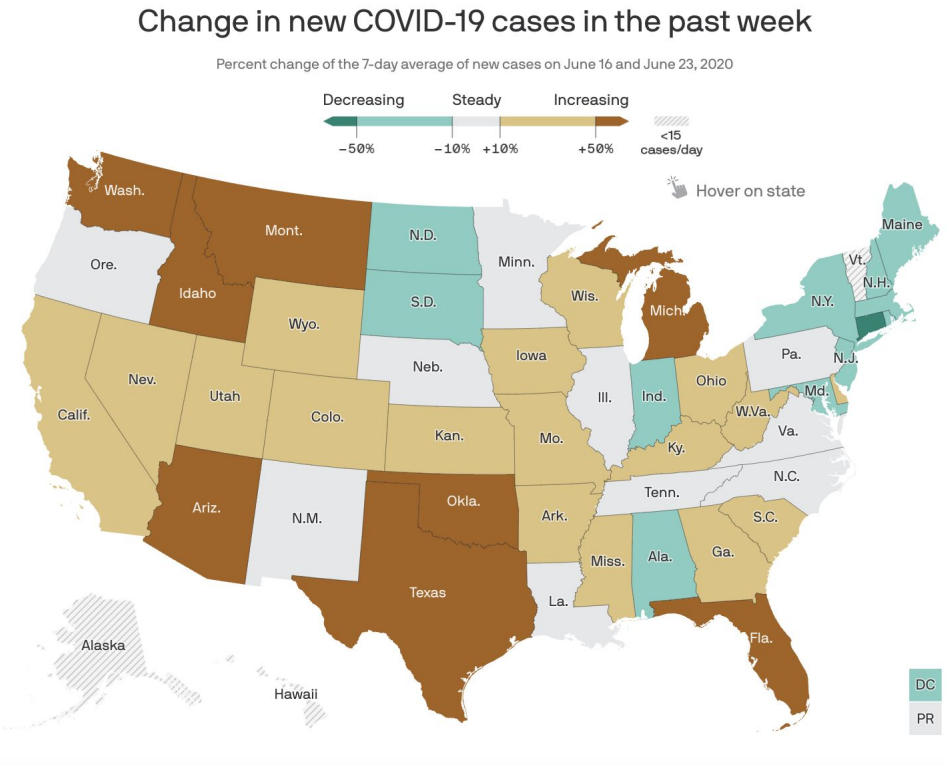
How to Choose the Ideal Colours for Your Visualizations

- Sequential palette — a single or multiple colours in a gradient in one direction
    - Best for ordered data



How to Choose the Ideal Colours for Your Visualizations

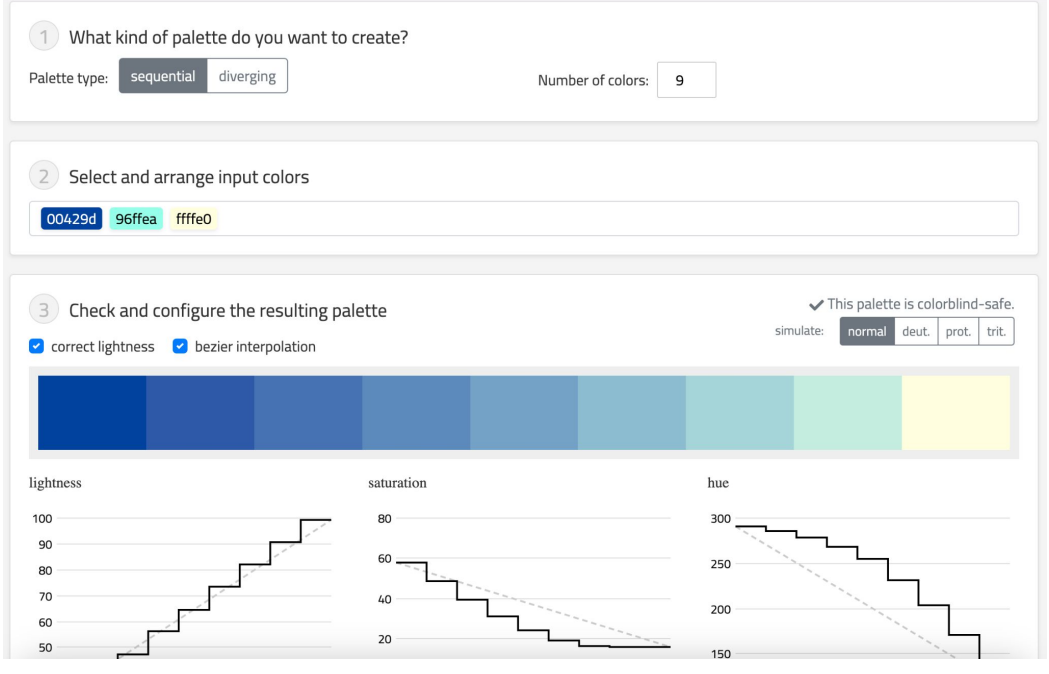
- Diverging palette — colour gradient in 2 directions
    - Best for data surrounding a clear midpoint or with extremes



Colour Palette Tools

– – –

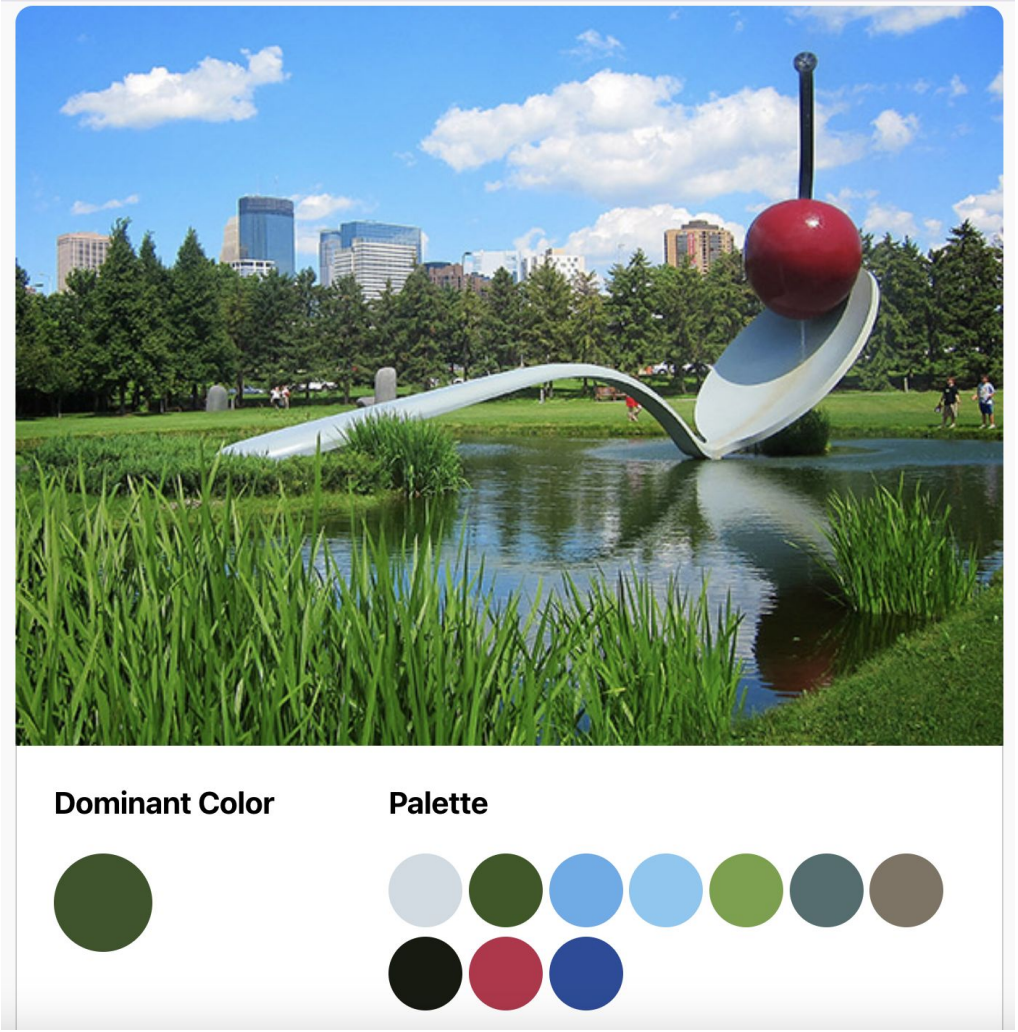
Chroma.js Color Palette Helper – https://gka.github.io/palettes/#/9|s|00429d,96ffea,ffffe0|ffffe0,ff005e,93003a|1|1



Colour Palette Tools

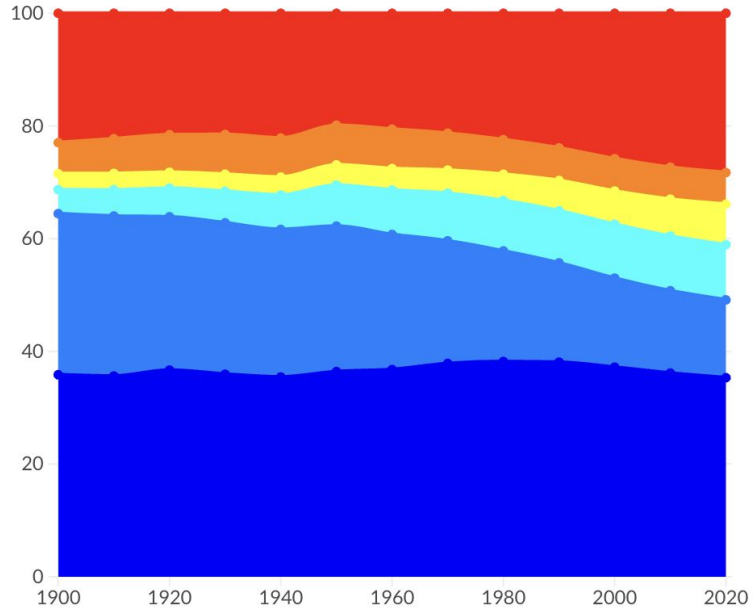
– – –

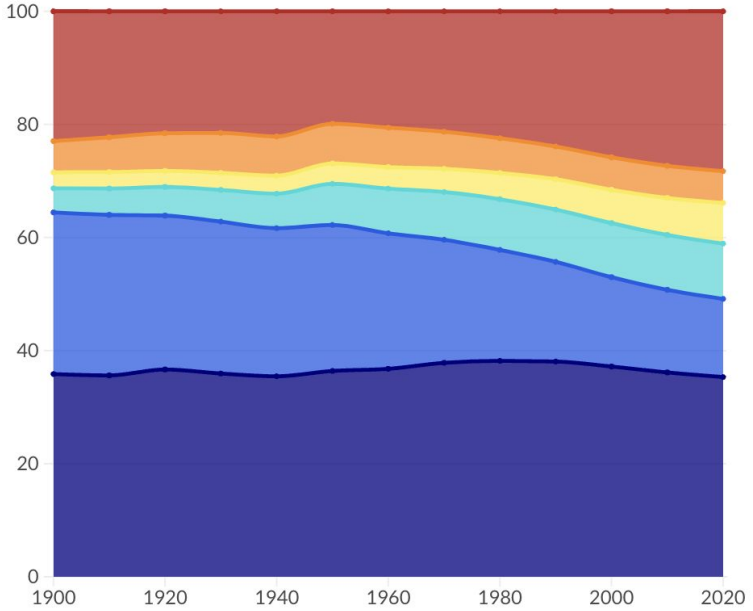
Color Thief –
https://lokeshdhakar.com/projects/color-thief/#getting-started



Some Common Colour Choice Pitfalls

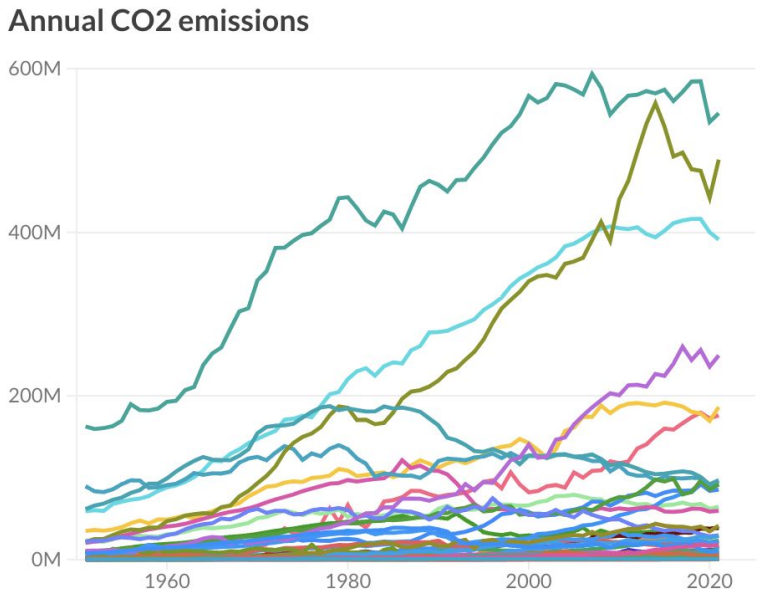
Overuse of bright colours

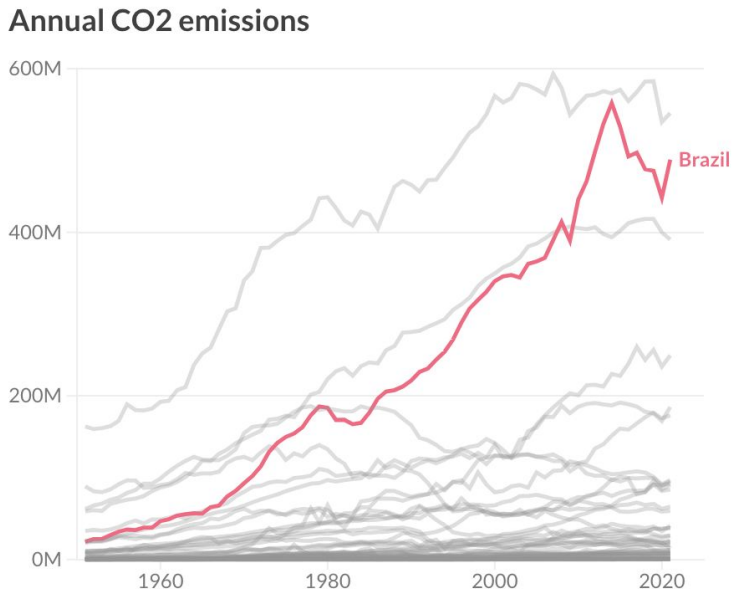




Some Common Colour Choice Pitfalls

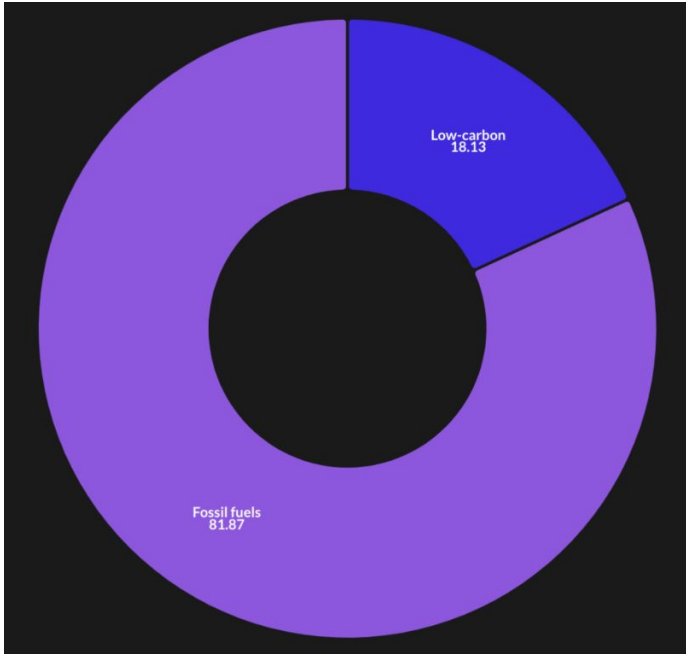
Overuse of colours

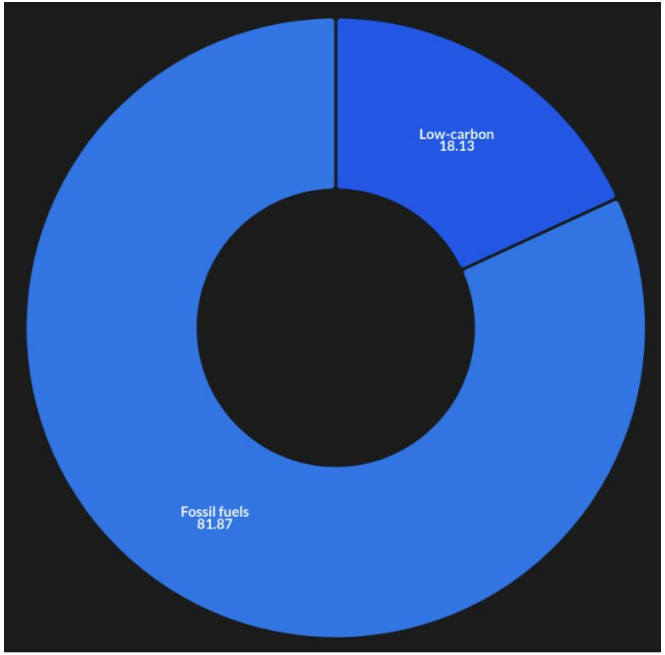




Some Common Colour Choice Pitfalls

Lack of accessibility consideration

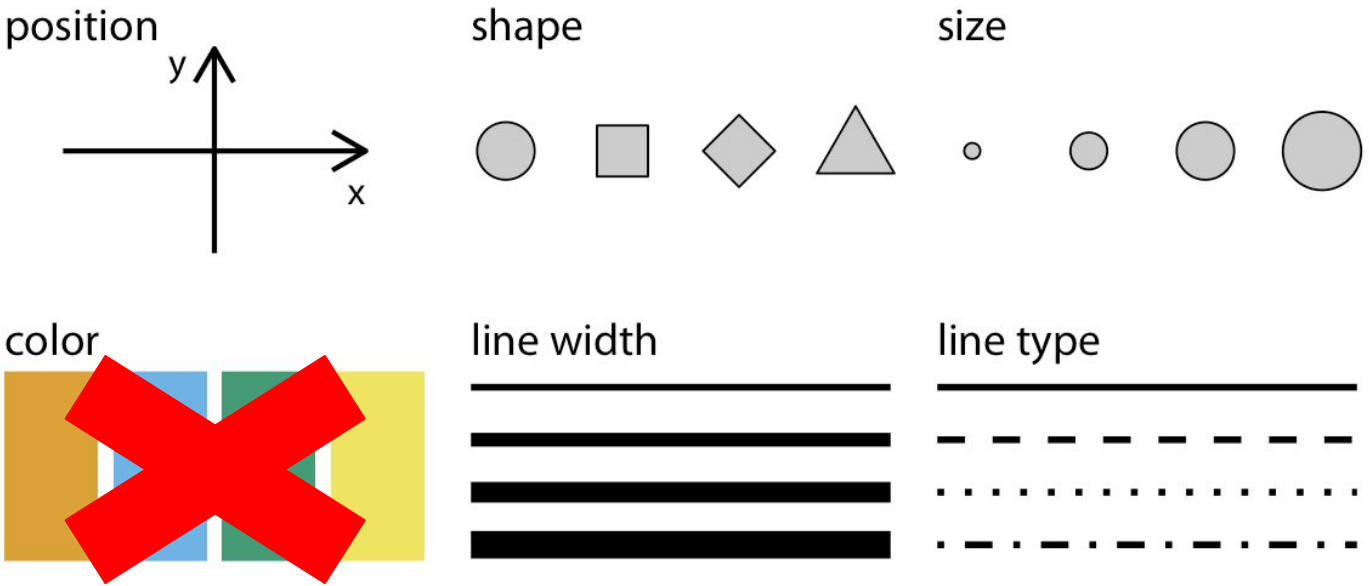




Some Common Colour Choice Pitfalls

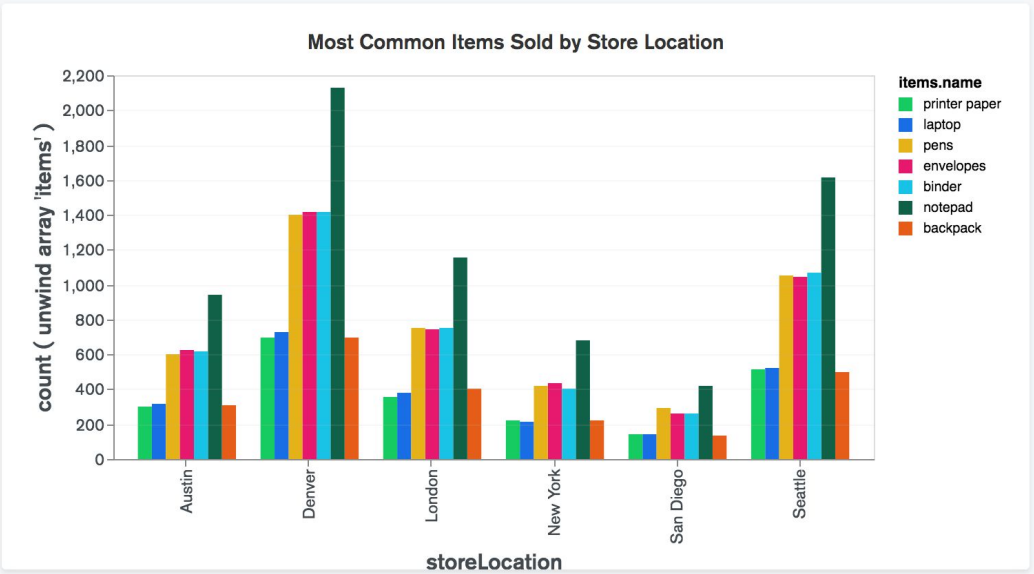
Lack of Contrast

Other Aesthetic Principles to Consider



Position

- Position of elements in your visualization can help to convey hierarchy and/or group relationships in data
- Space and positioning can be used to group related data points or to emphasize key findings
- Consistent positioning can aid in readability and comprehension for your audience

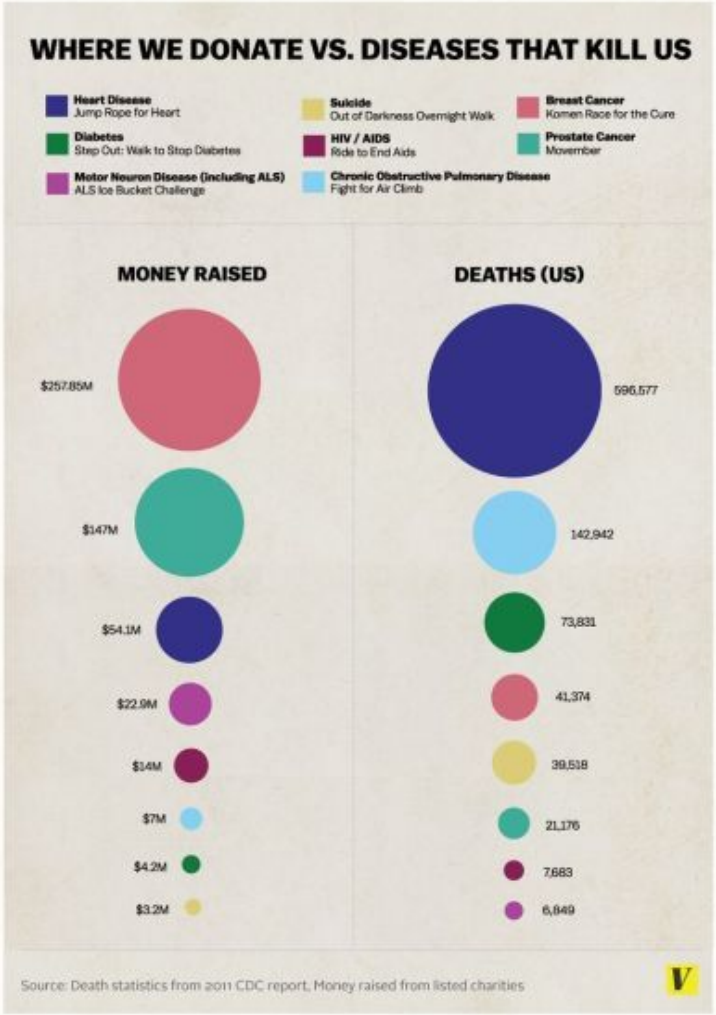


Shape

- Shape can be used to represent different categories in your data
- Choose shapes that are easily distinguishable for your audience to interpret
    - Especially important when colour differentiation is not an option
- Variation in shape can aid in ease of pattern recognition

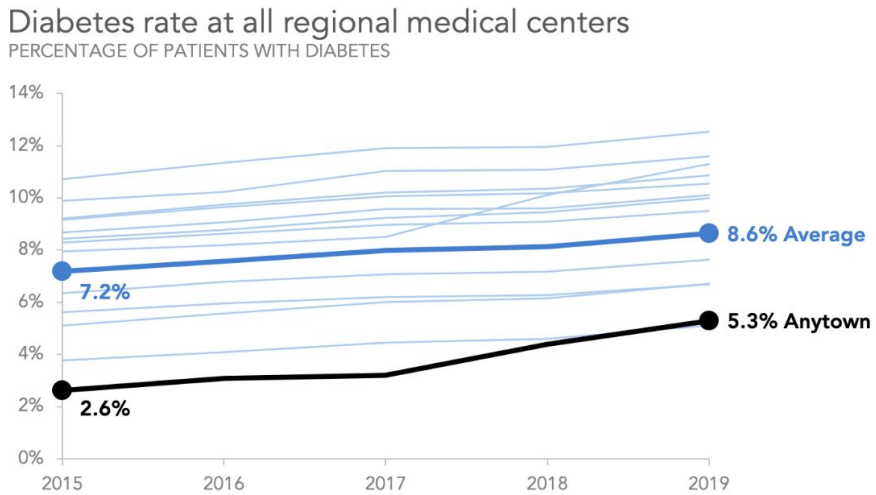
Size

- Size can be used to represent quantitative values or to emphasize particular data points
- Larger sizes typically indicate greater magnitude or importance, while smaller sizes suggest smaller magnitudes or lesser importance
- Use size carefully to avoid distorting how your data is represented to your audience



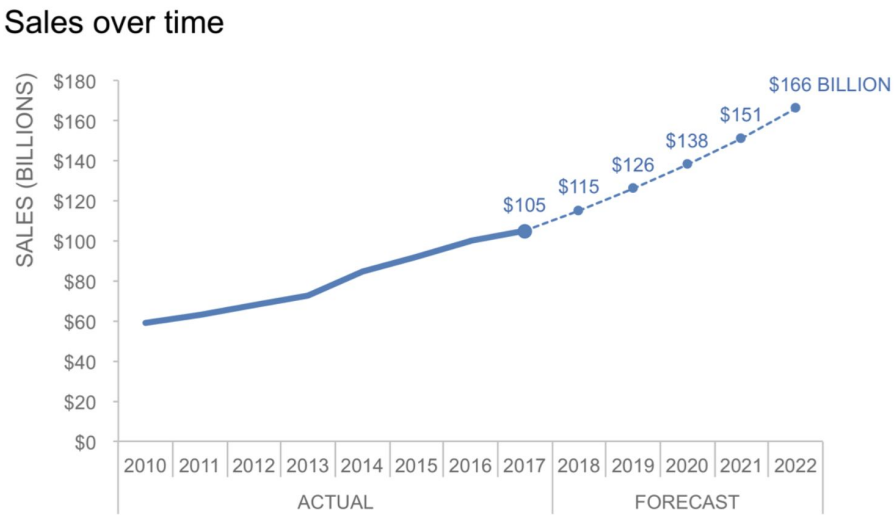
Line Width

- Line width can be used to denote strength and importance
- Thicker lines can draw attention to and emphasize key trends or relationships
- Thinner lines can be used to represent more subtle relationships or other less important findings



Line Type

- Different types of lines (e.g., solid, dashed, dotted) can be used to differentiate significance, time points, uncommon findings in your data etc.
- Dashed or dotted lines can represent uncertainty or indicate breaks in continuity
- Varying line types can help your audience to distinguish between different data series



Practical Aesthetic Considerations for Creating Data Visualizations

– – –

- Audience:
  - Understand the individual factors (e.g. cultural background, subject expertise, etc.) of your audience to create visualizations that make sense for them
- Purpose:
  - Clarify the message of your visualization before selecting colour schemes and aesthetic elements
  - Choose colours and aesthetics that support and enhance the communication of your key findings and insights
- Clarity:
  - Keep your visualizations simple to avoid overwhelming your audience
  - Use simple design elements to convey information effectively and increase ease of comprehension

Practical Aesthetic Considerations for Creating Data Visualizations

– – –

- Colour:
  - Select colour palettes that are visually appealing and appropriate for the topic of your research/visualization
  - Select colour palettes that are suitable for the type of data you want to visualize
- Contrast:
  - Ensure high contrast ratios between your text, data, and background for ease of understanding
- Accessibility:
  - Consider potential accessibility needs of your audience, including colour blindness and visual impairments
  - Provide alternative ways of accessing the information represented, such as text descriptions in a caption

Thanks For Listening!

Any Comments or Questions?